SUPPLEMENT.

The Mining Journal,

AILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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Royal School of Mines.

. WARINGTON SMYTH'S LECTURES ON MINING.

URE XLIV.—He had placed before the students some account ppliances by which water-power was applied to mining pur- ncluding some which were used for raising the mineral; but he last half-century a great change had taken place in re- the latter. Indeed, if they looked back a few years further nge was still more marked, and they would find that where r-wheel was then invariably to be seen the steam-engine had now taken And whereas the steam-engine itself, when it first came into use, applied as an auxiliary power to supply the water-wheels with the re- eight of water, it had been found from year to year more convenient y steam-power directly, and especially so after the discoveries of Boul- Watt rendered direct application easier and more inexpensive. For purposes vertical cylinders were generally employed, varying greatly rom a very small diameter to as much as 100 inches, and with strokes rom 5 to 9, or even 10 feet. Pumping-engines were at the first used way with a heavy beam, at the one end of which was fixed the piston- , at the other the main pumping-rod. In the present day vertical en- employed for winding up the material as well as for pumping, for of which he might refer them to the Monkwearmouth, the Hetton, n Delaval Collieries, and many others. There were a great many of the Boulton and Watt engines on a double-action principle, but hori- linders are at the present time the most largely used, on account of their mpactness and the smaller expense of their erection. For the pur- ressing, grinding, and stamping the ores, a number of modifications are employed, but they are all, more or less, akin to the Boulton and ines. In Cornwall it is usual to employ steam at high pressure, and ne time to make use of conde rs, and from this system a much greater esulted in the western districts than in any other in the application power. Of course, the question of economy depended in a great de- the construction of the boilers and the adoption of forms in which f fuel is combined with simplicity, and for these purposes, perhaps, more suited than that adopted in Cornwall. In the colliery and ma- ng districts the simple cylindrical boiler, with egg ends, or the tu- r, which the miners in Cornwall devised long ago, was now adopted. iple of the tubular boiler, introduced at the beginning of the present as one of the greatest improvements that had taken place in confec- steam-boilers. Mr. Fairbairn and others had been in the habit of ng these boilers with two tubes instead of one, and another modifi- that of constructing cross-tubes between the two principal tubes, so er facilitate the passage of the heated water from one part of the nother, and so obtain a larger heating surface. This plan also added the strength of the boiler. He would not occupy their time with any tails on that topic, as he should have to go into them more fully in f the drawing of the mineral and the pumping of water out of shafts. therefore, pass on to consider the class of apparatus employed for wind- neral from the bottom of shafts (more or less vertical), winzes, &c. this description of work that hand-labour came more largely into h not so much in collieries as in metalliferous mines. This manual very often conveniently employed in raising the material by means es from the shallow winzes which were so frequently sunk in metal- ines. Especially was it advantageous where a bad system of un- ding was pursued, and where a number of windlasses would most e erected for winding the mineral. It was, therefore, very desirable should make themselves acquainted with the best form of windlass pparatus. Sometimes, as in the case of an accident, it might be ne- employ a windlass in drawing from great depths, and thus while the pth of shafts at which windlasses were employed is not more than it might be necessary to introduce them in shafts of 30 or 40 fathoms, re, in depth. Mr. Smyth entered into considerable detail with re- different kinds of windlasses in use, the chief point in connection being the diameter of the drum, which varies very considerably, the being 3 feet, which occurred at a mine in Spain. A number of ex- ad been conducted by several men of great eminence in the mecha- to determine the amount of work that might be expected to be per- windlasses worked by manual labour, amongst whom were Coulon, mathematician; General Moran, Mr. Walker, a civil engineer; and ach, of Freiberg. The result of those experiments did not differ erably, and hence he would only lay those of Prof. Weisbach before t gentleman had found that two men working in a pit 40 yards deep, of eight hours, were capable of raising a weight of 17 lbs., at a ve- 10ths feet per second, hence the total quantity raised in the eight be 8 tons 12 cwts. 86 lbs. The lecturer next alluded to the ropes used for drawing in shafts. In former times hempen ropes were al- sally employed, the only exceptions being in some of the mines in England, where chains were adopted. The hempen ropes were gene- ound, of three strands, and had a certain quantity of tar mixed especially if they were intended for use in engine-shafts. They were thicknesses, according to the kind of power employed, whether horse, ater power. A great improvement which took place in the manu- empen ropes was to sew several of them together, and thus form a These possessed a great deal of rigidity, as well as other advantages. were in use great care should be taken to prevent them from coming with the sides of the shaft, or with pieces of projecting rock, other- rope might be completely cut through in a short space of time. The pen rope in the case of a deep mine was a matter of some importance. urse, necessary that they should be of considerable thickness, and very greatly to their cost. In the year 1832, some miners in the g to work at great depths, began to employ iron wire-ropes instead he latter being found exceedingly expensive.

gary the practice of employing wire-rope passed into Saxony, but, ay, although iron wire-ropes possessed several advantages over , the former had been in use a long time on the Continent before troduced into the mines of Great Britain. It was found on the Con- although iron was not particularly cheap, as compared with hemp, great economy resulted from the use of ropes made of that material, count of its durability, and partly in consequence of its lightness, with hempen rope. The person who introduced iron wire-ropes into s Mr. Lewis Gordon, who entered into partnership with Mr. Newall, foundation of the well-known firm of R. S. Newall and Co., who atent for the invention. The practice of employing wire-rope had very extended, not only in mining operations but in the rigging of not, however, thoroughly taken root in metalliferous mines, owing, to its advantages not being understood, and to the circumstance ication had not been attended with that care which was requisite full amount of economy from it. It was obvious that a rope con- ew wires must not be brought too rudely into contact with the sides , and that it must not be wound too rudely over the pulleys. It was give wire-rope a fair trial if pulleys of only 1, 2, or 3 feet diameter s was frequently the case in metalliferous mines. The diameter of uld not be less than 5 or 6 feet, nor should the pulley be of less di- If the shafts were very irregular in form, rollers ought to be employed, ope from rubbing against the sides. Wire-ropes were made of dif- and sizes. In some instances they were composed of many small twisted together, whilst in some districts—as in Hungary—they few wires of large diameter, and very slightly twisted. They would rstand that if wire were twisted as sharply as hemp it would be reak, and he believed that in many instances wire had been twisted degree than it was capable of consistent with safety. Flat ropes made of iron wire, and this variety had had a very extensive run rs in collieries, and from their first introduction, up to a few years ought there was no kind of rope equal to them. They were very than hempen ropes, and had the advantage of overlapping one turn on the drum. Another advantage attending them was that which to the flat hempen ropes—that there was a much greater regularity the shaft, instead of the constant contortion and twisting in the ropes.

e prejudice was felt towards the wire-ropes on their first introduction, owing to the reluctance of the men to trust their lives to so slender, and apparently so weak, a support; but, nevertheless, the good work effected by them soon made them to be valued by the miners. In the case of very deep mines, it would be almost impossible to carry on the workings unless wire-ropes were used, in consequence of the very small quantity of material they would be able to raise if any other kind of rope were used, on account of its great weight. Steel ropes had also been brought into use in this country and Prussia, and so far as they had been experimented with they had given satisfaction, but they had not been adopted on a sufficiently large scale to judge positively of their merits. Steel being of smaller diameter than iron, greater care was necessary in seeing that it did not pass over so small an angle as to snap it, and that it should not come into contact with the rocky sides of the shafts. Chains of various kinds had been largely employed for drawing loads in shafts, more especially in metalliferous mines, and there was, at all events, this great convenience about chains, that they might be allowed to pass over pulleys of comparatively small diameter, that less damage would result to them by coming in contact with sides of shafts, and that with chains several shafts could be served by one engine. Single-link chains, with whatever care they were used, were very liable to break, and if only one link were of inferior quality it would be just as disastrous as if the whole chain were of the same character. Besides, it must be remembered that chains, rubbing as they did over a large number of guide pulleys, were subject to that change of structure which had been so often commented on in respect to the axles of railway wheels and other wrought-iron articles—that although the iron might when manufactured have been of a tough description, yet after a time it become brittle. Another variety of chain, which was extensively in use in the central districts of South Staffordshire, Worcestershire, and parts of Shropshire, was the three-link chain, a very strong, but, at the same time, a very ponderous chain, having the appearance of a flat rope. One advantage possessed by this chain was the extreme improbability of the whole of the three links breaking at once, whilst if one broke it fell out of position, and was at once observed. He had heard of one or two cases of chains of that class being wholly fractured, but they were exceedingly rare. The chief objection to their use was their very great weight, being from 10 to 16 or 20 lbs. to the yard, hence it might be readily conceived that when they had to deal with a depth of 200 yards it would be very desirable to introduce some other kind of rope. Another material which he should mention as having been very largely used in some parts of Europe, for very deep mines, was the fibre of the common American aloe. He had been told by persons who had resided in Mexico that, although made up in a rough way, it was an extremely valuable adjunct to the mine, and that they could raise materials from very great depths by its aid. It was an interesting fact that in Belgium, where, as he had already intimated, some of the deepest collieries in the world were to be found, ropes manufactured from the fibre of the American aloe were very extensively used, and were found extremely serviceable. It was of considerable weight, being heavier than hemp; yet, nevertheless, what with its lower price, and its greater durability, the Belgians prefer it very much. The average weight of the ropes used at the large collieries of the Grand Hornu, in the Mons district, was from 8·76 to 8·88 kilos. per metre. These ropes, which were made to taper, being thicker at the top than at the bottom, were calculated to carry an enormous weight, the iron cages weighing 1224 kilos., and the load of eight tubs of coal, each carrying 2800 kilos. He was informed by the manager of several of the collieries where these aloe ropes were used that they had been tried against other kinds of rope, and the results had been greatly in their favour.

LECTURE XLV.—In continuing his notice of the machinery by which ores and other materials are raised in the shafts of mines, they next came to cases in which more than mere manual labour is to be used, and the problems which they presented for solution. When winding is to be done by human labour, the windlass is placed immediately over the matter to be raised, but when mechanical power is used it is found more convenient in most cases to place that power at the side, and bring it to bear by the use of ropes and pulleys. This necessitated the use of frames to hold these pulleys, which, when connected with deep workings and extensive machinery, involved the expenditure of much capital. The simplest mode in which other than manual labour was employed was in metalliferous mines, where horse-power was applied by what is called the whip and derry. This simply consists in erecting a pulley over the shaft, on a sort of square frame, to hold the pulley-wheel, over which a rope is passed, to which the horse is attached, it being trained to walk a proper distance on a road laid down with stone for that purpose. The inconvenience of this system was that the horse had to make a great struggle when the weight to be lifted was at the bottom; and, by the same rule, in making the descent there was a constant tendency to increase the velocity, so that if the horses are not well trained and steady there is a great waste of power, and not a little danger. This plan, therefore, can be recommended only in the case of temporary works, and at no great depth. For horse-power, however, the general arrangement is a wheel and axle kind of machine, called a horse-gin, or whim, consisting of a rope-drum built round a vertical axis, the foot of which turns on a stone, or on an iron casting, and the head part of which is supported by a long span-beam, resting at the extremities upon inclined legs. Attached to this is an arm or arms, which must be of considerable length, generally from 30 to 36 ft., and it embraces the vertical axis close beneath the drum, which is, in coal mining, from 12 to 16 ft. in diameter. The ropes passing off from the opposite sides of the drum, are conducted over little guide pulleys, called jackanapes, to the sheaves set in the shaft frame overhanging the pit. These could also be worked by hand labour if on a smaller scale, and were more effective than the windlass, as had been found by experiment. Horse-whims were, however, now more usually employed than the hand-whim, except in small experimental adventures in Cornwall. In the coal districts, as soon as any considerable depth was attained, steam-power was invariably introduced, but in Hungary, in Spain, and in Mexico, where it was difficult to employ water or steam power, the construction of the whim became a serious matter, both on account of the great depths for which it was used and the number of horses required; and a variety of attempts at improvement had been made. One of these (and he recommended the students to make a copy of the drawing by which he described it), instead of coiling the rope on the open drum, had projections by which each coil was made to overlap the other, so that they got the advantage of a diminished radius of the drum as the rope was wound off. This kind of whim required a little more expense in respect to the drum, but it was one which, by its economy of power, was worth keeping in mind by those who had to do with metalliferous mines, where whims were often used to a depth of from 60 to 100 fms. These depths, indeed, were moderate compared to those in foreign countries. In Hungary the mines were 200 fms. deep, and all the mineral had to be raised by horse-power. In Spain experience had shown that horse-power could hold its own against steam, because, besides the expense of getting weighty machinery carried up the mountains, the cost of bringing coal from a distance, and other outlay, outweighs all advantages in other respects. And if they went a step further, they would find that in Mexico, and some of the mines in Spanish America, horse or mule power was a long way preferable to steam-power. Hence some English companies had lost a deal of money by sending out steam-engines to places where they were not applicable, and where it would have been better to have trusted to the horse-whim. Perhaps the most remarkable instance of the employment of this form of power was one described to him by Mr. Brough, one of Her Majesty's Inspectors of Coal Mines, which he had seen at Granada, in South America, where a number of horse-whims were working at the same time in the same shaft. The shaft was of enormous dimensions, and polygonal in form. On each side of the polygon was a whim, worked by 12 mules, which alternately drew all mineral or all water from a depth of 300 fms. In Hungary there was an approximation to this, because the shafts there were often larger. In Saxony, however, the drums are of comparatively small dimensions, but, on account of the great depths for which they are used, they are fitted with a most elaborate arrangement of brakes, for the safety of those employed below. In that country, too, each whim had a peculiar conical roof erected over it; and, indeed, those roofs were a noticeable characteristic of the coal mining districts of Eastern Europe. In this country they were unprotected from the weather, but a paling of gorse is often placed around the path on which the horse travels. The principle of the whim is precisely that of the wheel and axle, and, therefore, the power is easily calculated. A horse, with a velocity of 2·9 ft. per second, would exert a constant force of 95 lbs. at the extremity of the axle, so that the unit of work done would be 16,530 lbs. raised 1 ft. high per minute. In our country a good deal depended on the pit whim being put opposite the wheel, so as to diminish the friction; and this is especially important where it is found convenient to put up a horse-whim at some distance from the shaft. The lecturer then spoke at some length upon the size of pulleys, which during the last 30 years had increased from the old average of about 2 ft. diameter to 6 or 8 ft. in metalliferous mines, and in collieries to as much as 20 ft. These increased sizes had led to enquiries as to whether some other material than cast-iron should be employed, and a plan patented by Messrs. Newall and Co. to lighten the wheels was considered a great improvement. The question of pulley-stands was only a matter of carpentering on a large scale, which every mine manager ought to be able to direct; and by a series of models and drawings showed the best and most effective contrivances for securing due strength and steadiness.

LECTURE XLVI.—There was a great difference in metalliferous mines and collieries in respect to the use made of the shafts. In the case of the first, exertions are made, not only to get as much mineral through the shafts as possible, but very frequently the men had to travel by them; and thus not only had speed to be attained, but every precaution must be taken for security. In spite of all precautions, however, it is well known that out of the large number of accidents which occur a great proportion of those which prove fatal take place in the shafts during the travelling of the men up and down. This is by no means a result confined to the breakage of ropes and chains, although a great many arise from that; but the old system of drawing up, in which the bucket or skip was allowed to hang free in the shaft, was full of danger. The contortions and twistings of the rope turned the cage round and round, and brought it repeatedly into contact with the sides of the shaft; but, besides this, there was always the very considerable risk of the up going and down coming cages having a collision at the point of meeting. This, indeed, was always looked upon as so dangerous that it was usual to slacken the speed of the engine as the cages approached each other, so as to allow their occupants to take measures to prevent their clashing. The buckets, or kibbles, used at that time in winding coal (the word for them in German is "Kübel"), and which are still largely used in the raising of metallic minerals. In the olden time simple buckets, made of wood, hooped with iron, and either of a circular or, as in Saxony, of an elliptical form, were in vogue. In England sheet-iron had been used for some years instead of wood, and in the mines of the western districts wrought-iron had been largely adopted, as being calculated to stand a great deal of wear and tear. Baskets used to be commonly employed in raising coal, but they were scarcely ever seen in these days. Contemporaneously with the baskets there a kibble of enormous size was in vogue in Belgium, and at certain collieries in the neighbourhood of Bristol and Bath, generally made of sheet-iron, which simply travelled up and down the shaft, and which was conveniently filled by being lowered until its top came opposite the floor of the level, when the material could be thrown in. These were generally constructed to hold 1 or 1½ ton, and on arriving at the surface the mineral was simply tipped out on the pit-bank, giving rise to the formation of a considerable amount of small coal. A radical change, however, had taken place in these arrangements at nearly the whole of our northern collieries, and which must ultimately extend to a large proportion of those which had not already adopted it, and that was the system of drawing by cages and guides. It was curious enough that in the last century, when the miners of Saxony were employing guides to regulate the ascent and descent in their shafts, with very great advantage, it was entirely overlooked in this country, except in the case of certain pits near Sheffield, under the management of Mr. Kerr, a colliery viewer of that day, who seemed to be considerably before his generation in many points. It was not until the year 1829 that guides were introduced at some of the mines in the Somersetshire district, and not until something like ten years later that they began to make their way to the North of England; but shortly after this quite a revolution was brought about, and in the course of a very few years there were hardly any large pits that had not adopted them. The practice of employing guides made it convenient to introduce cages into the shafts, in which the wagons or tubs were placed. One great advantage connected with cages was that there was no transhipment of the coal, and consequently a less percentage of small coal, whilst the facility of working when cages were adopted combined with perfect security, was such that it was only by their instrumentality that it was possible to raise the large quantities of mineral produced at some of the larger collieries. As to the mode of putting in the guides, perhaps the simplest plan was that adopted at some of the Lancashire collieries, in which a pair of wire-ropes were stretched from the bottom of the shaft to the pit head frame, on which the cage travelled. This was an extremely simple plan, and very convenient whilst sinking. The next plan in advance was that of employing cylindrical iron rods, which gave a much greater stiffness and regularity of action than the ropes, which swayed to and fro in the shaft. The rods also frequently came in handily for communicating signals in the shaft, as, on being struck with a hammer, they gave out a peculiar vibrating sound, which could be heard for a distance of 200 or 300 yards. At by far the greater number of collieries it was found most convenient and economical to fit the shaft with simple wooden guides, which were generally made of Baltic pine, 4 by 3 in., or 5 by 4 in. in thickness. These guides are placed in the shafts in various positions. A shaft, for instance, might be divided for various purposes, such as for the ventilation—one-half to act as the downcast and the other half the upcast; and in this case the guides might be fixed on the one side to the bratticing dividing the shaft, and on the other to the side of the shaft itself. Mr. T. E. Forster, an eminent colliery viewer, of Newcastle-upon-Tyne, who had the charge of some of the largest collieries in the North, had employed as guides bridge rails of rolled iron, which he affixed to the buntings. These rails were extremely firm and durable, and it was worthy of note that they had been adopted at pits doing an amazing amount of work, and where the drawing was accomplished, perhaps, with a greater rapidity and ease than at any pits in the world. Passing from guides to the consideration of cages, the lecturer said there was a very great variety to look at. Cages were almost invariably made of wrought or malleable iron. They differed, according to the magnitude of the work to be done, in being either single or double; and the latter might either carry two wagons side by side, or they might have two decks, or stages, in them, and thus be capable of carrying four tubs. If they were intended to carry four tubs, they must be made very strong. Hence cages were sometimes of very great weight; a moderate sized one weighing 24 cwts., whilst many weighed as much as 1½ and even 2 tons. That, of course, was exclusive of the material to be raised, as well as of the tubs, which often weighed from 3 to 4 cwts., besides the coal, which often would be 10 or 11 cwts. more. To lighten the cage was, therefore, a matter of importance, and Mr. Forster and other northern viewers had latterly been trying steel cages, which reduced the weight without lessening the strength. This was likely to prove a valuable change, but the experiment had hardly been tried long enough to justify a decided verdict upon its merits. In Belgium cages of enormous size, with two or three superincumbent stages, were employed, specimens of which they might remember in the Exhibition of 1862. The largest cages in use in the world were probably those of the Grand Hornu Colliery, near Mons, which consisted of four decks, each of which held two tubs. The method of loading this cage at the bottom of the shaft, which was very ingenious, and enabled the work to be accomplished in a most expeditious manner, was as follows:—At the bottom of the shaft a level branched off on each side, and at a short distance from the mouth of each level a small winze was sunk, of just sufficient dimensions to allow of a tub of coal being let down into a small passage, which communicated with the shaft at a lower point than the level above referred to. The object of this was to allow of the loading and unloading of two of the decks of the cage to be carried on simultaneously on each side of the shaft, the first and third deck being filled on one side, and the second and fourth on the other. The tubs were let down from the levels into the lower passages by means of a pulley and rope. One great point in regard to rapidity in raising the mineral was to see to discipline amongst the men, as attention to this might in some cases double the quantity of mineral raised in a given time. One or two cases had come under his own observation lately, in which the output had been increased from 200 or 300 tons a day to 400, 500, or 600 tons in the same time, and with no larger a number of men, solely in consequence of attending to this point. It was only by a proper regard being paid to this matter that it was possible at some collieries to raise so large a quantity as 1000 tons in a day, or, as the Great Hornu, from 1200 to 1300 tons. Having explained, by models, some points as to drums, he drew attention to the necessity in deep pits of some counterpoise to the weight of the rope, &c., so that in the lower part of its descent the tendency to run off at a high velocity might be counteracted. As instances of the successful applications of this kind, he mentioned the Berchaven Copper Mine, in Ireland, the Aberdare Collieries, in South Wales, and the Kirkless Hall Collieries. A contrivance of M. Lemielle, to introduce the use of the endless rope for this purpose, would have been more useful if that gentleman had been cognisant of Fowler's clip-pulley. That, incorporated with Lemielle's endless rope, would have added materially to its value. The clip-pulley, he might observe, was in operation at Messrs. Pease's extensive works in the North, at the Shire-oaks Colliery, near Worksop, and at other places; and it was found to work very well, and to diminish the wear and tear of the ropes. Speaking next of

the accidents occurring in shafts, and the means adopted for their prevention, the lecturer remarked that this class of accidents was much more numerous than might reasonably be expected, and resulted in some cases from habitual carelessness on the part of the men. After referring to several kinds of guards which were in use at the mouths of shafts to prevent persons from falling down, Mr. Smyth said that from the year 1848 to the present time a great number of inventions had been brought out, with the view of preventing accidents by the breakage of the ropes and chains, most of which were very ingenious, but very few were found fairly compatible with convenience in practice. These went under the name of safety-cages, safety-clutches, and, in France and Belgium, parachutes. He would not go into the merits of the whole of those inventions, but would observe that they resolved themselves into two great classes—one class being designed to bring two levers into action at the moment of the breakage of the rope, which flew out and clutched the guides, and so held the cage. One of this description ought to be mentioned as having been adopted at the great French Collieries of Anzin, at Fontaine, and it was stated that it had saved a great many lives, no fewer than 100; though he did not think that fact said much for the quality of the ropes employed, whatever it might say of the cage. The other class were those which, on the fracture of the rope, impressed themselves against the sides of the guides. One very largely in use in Lancashire was that invented by Mr. Owen, which possessed the advantage of great symplicity, and had proved itself capable of doing a great deal of work. By this method the weight attached to the rope was placed in such a position as to allow the cage to pass up and down the shaft. Affixed on either side of the cage were a couple of levers, and the moment the rope was slackened—whether by fracture or otherwise—the levers were brought into action by a couple of springs, and gripped firmly the opposite sides of the guides. An apparatus of a very similar nature was affixed to the travelling carriage of the Botallack Mine, in which the Prince and Princess of Wales descended on their recent visit to the mine. One great objection made by practical men to the use of safety cages was, that most of them did not wait for the fracture of the rope before coming into operation, but came into action whenever the rope, owing to the rapidity of the winding, made a surge—that was to say when the cage ran a little faster than usual and the rope slacked for a moment; the consequence of which was that the cage remained suspended in the shaft, the weight of a certain length of rope was brought to bear upon it, and one danger was substituted for another. Many of the inventions had had a fair trial, but had had to be abandoned; and most colliery managers seemed inclined rather to trust to the employment of good tackle. That by Mr. Owen had, however, saved many lives. A very ingenious one by Messrs. White and Grant, of Glasgow, had also been reported on very favourably. A good deal of interest attached also to one by Mr. Calow, which was an extremely ingenious apparatus, and acted independently of the fracture of the rope, so that the mere act of the cage falling caused the springs to come into action and to pull levers into such a position as to uphold the cage. It was very desirable that careful experiments should be made with some of the various classes of apparatus. He thought there were no less than twenty of them, it being quite obvious that the nature of the accidents resulting from the breakage of ropes was so very serious when they did occur, that it would really be a great boon if it were determined whether any of these inventions could be fairly recommended.

SOUTH WALES INSTITUTE OF ENGINEERS.

The quarterly meeting of the members of the South Wales Institute of Engineers was held at the Castle Hotel, Merthyr, on March 27,

Mr. GEORGE MARTIN, President of the Institute, in the chair.

At half-past ten o'clock a special meeting of the members was held, for the purpose of taking into consideration the alteration of a number of rules, and several of them were amended.

Among the members present were—Mr. George Martin, President; Capt. Murphy, Chepstow; Mr. T. F. Brown; Mr. A. C. Jones, Uskside Works, Newport; Mr. J. T. Wightman, Pontypool; Mr. T. E. Wales, Government Inspector of Mines; Mr. Jacob James, Newbridge; Mr. R. Bedlington, Mr. Lewis Lewis, Aberdare; Mr. Edwin Richards, Tredegar; Mr. J. Roe, Llynvi Works; Mr. Bodmer, Newport; Mr. E. J. Edwards, Crumlin; Mr. M. Bates, Cyfarthfa; Mr. D. Thomas, Cwmavon; Mr. G. C. Pearce, Mr. Moxham, Mr. Bennett, Mr. George Brown (Nixon and Co.'s Collieries); Mr. W. Adams, Cardiff; Mr. W. Vivian; Mr. Williams, Letty Shenkin; Mr. Wilkinson, Duffryn Collieries; Mr. Maynard, Crumlin; Mr. E. Brigden, secretary, &c.

From the walls of the assembly room were suspended a number of well-executed sectional plans, &c., of the Tillery coal seam, and Mr. Davies's self-acting steam-striker. There was also exhibited a capital working model of a patent safety-cage, by Mr. Thomas Jenkins, of the Plymouth Works, showing the principle upon which his invention is worked in the stopping of the cage in its ascent or descent in case of a breakage in the winding-rope.

On the President taking the chair, the SECRETARY read the minutes of the last meeting, which were signed by the President. Mr. Moxham and Mr. Maynard were appointed scrutineers of the balloting papers for new members, and in the course of the meeting they announced that the following new members had been elected:—Mr. George Atkinson, mining engineer, Coleford; Mr. P. B. Eassie, Gloucester; Mr. H. Williams Lewis, Plymouth Ironworks; Mr. Jenkin L. Thomas, engineer, Neath Abbey Ironworks; and Mr. George May, chain manufacturer, Neath.

The PRESIDENT said the next business was the election of office bearers, and the following gentlemen were elected:—

VICE-PRESIDENTS.—Mr. WALES proposed, and Mr. ADAMS seconded, the re-election of Mr. Richard Bedlington. Mr. D. THOMAS proposed, and Mr. WALES seconded, the re-election of Mr. F. Levick.

MEMBERS OF COUNCIL.—Mr. ADAMS proposed, and Mr. D. THOMAS seconded, the election of Messrs. Windsor Richards and Bedlington Curtis. Mr. WALES proposed, and Mr. D. THOMAS seconded, the election of Messrs. G. Banks and G. Cope Pearce. Mr. THOMAS proposed, and Mr. BROWN seconded, the election of Messrs. Edward Williams and Phineas James.

SECRETARY.—Mr. WALES proposed, and Mr. BEDLINGTON seconded, the re-election of Mr. E. Brigden as secretary.

The SECRETARY read the financial statement for the year ending Dec. 28, which was adopted.——The PRESIDENT said he thought the statement a very favourable one. No doubt the arrears were heavy, but he hoped that all the members would pay up their subscriptions as soon as possible.——Mr. ADAMS requested permission to ask one question—What was the number of members?——The SECRETARY: We have 154, but including myself 155; I sent out 154 circulars.

Capt. MURPHY wished to know if there was any objection to publish the list of members. He thought it would be advisable to do so, and such a plan was usual with other institutions of a similar character.——The SECRETARY said it was done every year; they were printed at the end of the volume of the society's Journal.

The PRESIDENT observed that after the voting papers came in they would have more members.——Mr. GEORGE BROWN thought there was very little progress made in that respect, for as members came in a similar number went out.——The PRESIDENT: I think we shall do very well if we keep up to 150 members. If we succeed in doing that I am sure we have no reason to complain. The next business is the discussion on Mr. Bedlington's paper, "On the Duration of the South Wales Coal Field." Perhaps Mr. T. Forster Brown will open the discussion, by asking Mr. Bedlington some questions on the subject.

There being no response, the PRESIDENT again rose, and said that at the last meeting of the members, at Newport, it was understood that Mr. Bedlington's paper should be discussed in conjunction with Mr. A. Bassett's paper, on "The Port of Newport, and its Coal Field." He found, from a letter he had received that day, that Mr. Bassett was unable to be present at that meeting, and therefore he thought they had better put that paper off, and go on as far as possible with the discussion on Mr. Bedlington's paper, and adjourn the further discussion till next meeting. He should be very glad to have the opinion of the meeting upon the subject. If they went on with Mr. Bedlington's paper that would keep them some time, and then they could keep the discussion open by adjourning it till Mr. Bassett was able to be present.

Mr. T. FORSTER BROWN said it appeared to be the wish among the members at the lower end of the room that the discussion on Mr. Bedlington's paper should be adjourned till Mr. Bassett could attend, and then the two papers could be taken together.——The PRESIDENT: If that is the wish of the meeting both papers will stand over, but I was in hopes some one would have commenced the discussion to-day.

Mr. BEDLINGTON said he had no objection to the discussion on his paper being postponed.—The discussion on both papers was then adjourned till the next meeting.

The PRESIDENT was sorry to say that Mr. Matthew Loam's paper, on "The Cornish Engine," must also be adjourned. Mr. Loam had written to him, saying that he could not be there that day. The next paper on the list to be discussed was Mr. G. Cope Pearce's, on "Mechanical Ventilation," of which the following is an abstract:—

Some persons advocate the furnace, while others prefer mechanical ventilation, and it is our duty to ascertain to the best of our ability which is the best. The merits of the furnace, its beautiful simplicity, and so forth, are well known. On the other hand, it can be said that in many cases mechanical ventilation will be found superior in overcoming friction, where the drag is very great, and in economy; however, we cannot shut our eyes to the fact that no matter how well a machine is made it is liable to stop unexpectedly. There can be no doubt that if machinery is used for ventilating we ought to lessen the chance of stoppage, by making it with as few moving parts as possible, for which reason the writer is decidedly against all kinds of reciprocating machines, composed of pistons, tanks, beams, spur-wheels, cranks, numerous flaps, and so forth. The only machine, in his opinion, likely to have the least chance with the furnace is the fan, but it ought to be made very large, so as not to require the engine to work at too great a velocity. Shallow upcasts are sometimes found insufficient, and it is a common practice to build stacks at the top to increase the draught; but, as the quantity of air passing only increases with the square root of the depth, the ventilation will not be increased to any great extent by adding a stack, without it is built much higher than is the common practice, and thicker also to retain the heat. In a situation of this kind a fan is likely to be useful, and there are cases where a fan can be applied, but where a furnace would be quite out of the question. Mr. Pearce concludes that the economy of a fan as compared with a furnace depends upon the depth of the upcast. Where pits are shallow a fan requires far less coal, and that of an inferior quality; but there are cases where the quantity of coal saved will not pay for the increased first cost and working expenses. Mr. Atkinson states that on one occasion at Hetton Colliery, when 225,176 cubic feet of air per minute were circulating, the pressure per square foot was 18·099 lbs., answering to 3·48 in water-gauge. The depth of the pit was 300 yards. Mr. Atkinson also states that "taking the average of 11 different collieries in the Newcastle district, each pound of coal puts 13,000 cubic feet of air into circulation by the action of furnaces. In some collieries two or three times as much air is circulated by each pound of coal as in others, depending on the depth of shaft and its state of dryness or wetness, and on the friction of the air in the shafts, and in the mine itself." According to this statement 225,176 cubic feet of air could be circulated by about 11·13 tons of coal per 24 hours, so it is quite clear that in this case mechanical ventilation would have no chance in competition with the furnace, for to do this with a fan, the water-gauge at the fan would have to be at least 4 in., which would require a fan 30 ft. in diameter to make 80 revolutions per minute, and the engine-power necessary would be 296·33 horse-power, consuming 26 tons of coal per day, taking a horse-power at about ·088 tons per 24 hours. Previously to the erection of a fan at Pelton Colliery the ventilation was effected by furnace. The upcast pit was 112 yards deep by 7 ft. 6 in. diameter. The quantity of air obtained by ·9-in. water-gauge was 31,000 cubic feet, and the consumption of coal about 7 tons in 24 hours. If this upcast had been larger the duty of the furnace would, perhaps, have been higher; however, supposing that it had been as much as 55,000 cubic feet per minute, the experiments show that to do this with a fan an engine of only 23·6-horse power would be necessary, which would consume about 2 tons of coal per day instead of 7; so there can be no doubt as to the superior economy of the fan in this case as regards consumption of coal. In cases where the fan consumes less coal than the furnace, before we can tell which is most economical we must determine the cost of coal at the furnace underground, and the cost of small coal on the surface. Furnaces are generally supplied from coal left underground for that purpose, and some viewers think this coal ought only to be charged at what it actually costs to deliver it to the furnace; but others maintain that it is as valuable as other coal, and that by using it you lose what could be got by selling it, and that it ought to be charged at what you could get for it if sold. The writer has not had experience with ventilating machines himself, and has written this paper to provoke a discussion; but several members of the Institute have tried them, and they can, therefore, speak with confidence on the subject, and what he has omitted they will, no doubt, be able to supply. Discussion will doubtless elicit facts as to the quantity of air drawn, coal consumed, and so forth, by the furnaces in this district. The discussion was postponed.

Mr. WILKINSON, in response to an invitation from the President, opened the discussion. He said he was sorry to say that he had but very little information to give on the subject of Mechanical Ventilation; in fact, he was only a scholar, and came there for information. At their colliery they had one of Guibal's Fans at work, but he must confess he did not entirely understand it. He wished some information as to the shutters on the plans accompanying the paper.

Mr. G. COPE PEARCE explained that it represented them open and shut.——Mr. WILKINSON, in the course of some further observations, said that there was something in the shutters he could not understand at all, and his experience of the Fan was that the variation was very great, and he could hardly account for it. The Fan worked very well at 60 or 70 revolutions per minute, and he considered it to be a much superior method of obtaining ventilation than the machine they had before. He had made two experiments, the results of which he had committed to paper, and which the members were quite welcome to.

A long unreportable conversational discussion took place, in which members put innumerable questions to Mr. Wilkinson without addressing the chair. At length—

Capt. MURPHY said it would be much better for the gentlemen taking part in the discussion, for those who were desirous of obtaining information, and for the reporters, if gentlemen would address their observations to the Chairman; because, as the discussion was then being carried on, it was impossible to hear the observations made. It was the rule at other meetings for gentlemen to address the Chair, and he hoped the practice would be adopted at that meeting, so that all might be benefited by the information afforded.

A number of questions were then put to Mr. Wilkinson, his answers to which will be found in the accompanying tables. He also said that the diameter of the Fan was 30 ft., and the width 10 ft. He did not put an indicator on it, because it varied so much; 40,000 cubic feet of air was as much as he could get by Struvés machine, but from the fan he could get from 50,000 to 60,000 cubic feet. The engine was a separate one, but the boilers were connected with it; it used less steam than Struvé's, but they had it in work for such a short time that he felt he was not in a position to be able to give any definite opinion on it. He was not able to say whether it was more economical than Struvé's, but their engineer said it was. Its cost, including everything, was 1300*l.*, whilst the cost of Struvé's was 1900*l.* or 2000*l.* They had had Struvé's at work for 15 years, but this one they had only had 18 or 19 weeks. He ought to add that they had repaired Struvé's since it was erected, so that, in fact, it was equal to a new one. In his opinion Struvé's machine was the most likely to get out of order, whilst Guibal's Fan was very likely to run for many years without requiring any repairs. He considered there was danger to the men in the pit if the machine wanted to be repaired.

The following are the tables mentioned above as containing the information given by Mr. Wilkinson in answer to the questions put to him with regard to the results of his experiments:—

EXPERIMENTS UPON GUIBAL'S FAN AT THE MIDDLE DUFFRYN COLLIERY, TAKEN NEAR BOTTOM OF PIT, FEBRUARY 7, 1867.

Experiment.	Revolutions of fan per minute.	Revolutions of anemometer per minute.	Area of space in feet where experiment were taken.	Quantity of air per minute.	Water gauge close to fan.	Area of fan-shutter open.	Quantity of air going through fan.	Extent of shutter open.
1.	40	5·00	83·19	41,595	·60	35·00	56,000	36 × 12*
2.	45	5·25		43,674	·70	35·00	56,000	
3.	50	5·50		45,754	·80	35·00		
4.	60	6·50		54,073	1·10	35·00	66,500	
5.	70	8·00		66,552	1·60	35·00	98,000	
6.	50	6·00		49,914	·80	49·32		42 × 12
7.	50	6·00		49,914	·80	24·00		20 × 12

EXPERIMENTS ON GUIBAL'S FAN AT THE MIDDLE DUFFRYN COLLIERY, TAKEN NEAR BOTTOM OF PIT, MARCH 20, 1867.

1.	50	4·75	83·19	39,515		12·00	1 × 12†
2.	50	5·50		45,754	·90	36	77,000	3 × 12½
3.	60	6·25		51,993	1·20	36	91,000	3 × 12
4.	60	6·62		55,071	1·30	48	91,000	4 × 12
5.	70	7·60		63,224	1·70	48	108,000	4 × 12
6.	70	7·50		62,392	1·60	60	108,000	5 × 12
7.	50	5·42		41,944	·90	60	70,000	5 × 12
8.	50	5·42		41,944	·90	36	70,000	3 × 12

* Power stroke 57.600 air per minute. † Thermometer, 45°. ‡ Barometer, 29·62.

NOTE.—For the first half of experiments it blew a stiff breeze from the west, but for the latter half it had abated. The barometer stood at 29·83, and the thermometer 50. Powder-smoke gave the following result:—Travelled 69 ft. in five seconds=12 ft. per second. Assuming area=80, we have 80×12×60=57,600 per minute; but assuming same area as in experiments, we have 83·19×12×60 =59,896 per minute.—Air going down to ventilate the 6 and 9 ft. veins: Area, 49×9·75 revolutions=47,775 per minute. The maximum revolutions given to anemometer by old ventilator (Struvé's), 5×5×area 83·19=415, which is only equal to experiments No. 1 on fan.

Capt. MURPHY said that the whole matter of mining in this country was now become one of mechanical application, and he thought there was one small item in connection with mining which was really deserving the attention of mechanical engineers. He alluded to the doors used for splitting the air. He must confess he had not been down many collieries, but he had been down a few, and from what he saw of the doors he found that most of them were of the rudest character in construction, and he could scarcely believe such rude constructions were used when he considered their importance. He thought it was a subject of the greatest importance, especially when they were told year after year by Mr. Brough, Her Majesty's Inspector of Mines, in his report of the number of boys killed every year by those doors: children grew up to be men, and they might consider that every child killed was a man destroyed, and, therefore, when they saved the life of a child they saved a man's life. He held that the principle of having those doors of a rude description, and for boys to be employed to shut them, was wrong; and he thought that some mode might be adopted whereby they could be made self-acting, or made so as to raise up and down, slide backwards and forwards, or revolve; at any rate, so made as to require but little trouble, and incur less danger than at present in opening them; in fact, that the doors might be made into machines, instead of, as at present, rough pieces of wood put together, and pieces of canvas nailed over them. The draught in some pits was so very great that he really wondered that the boys were not often blown away altogether. He would place himself in communication with some gentlemen perfectly conversant with the matter, and if his opinion was considered worthy of attention, he would take the earliest opportunity of putting his ideas down on paper, which he would place before the members of the Institution at their next meeting.

Mr. JOHN WILLIAMS, of Lletty Shenkin, gave his experience as to mechanical ventilation and ventilation by furnaces; and in the course of his observations he said he considered the fan far superior to Struvé's machine, but he did not entirely agree with Mr. Wilkinson as to the quantity of air got by Struvé's, and said that if he could get the same quantity of air by the fan as he did by the ventilator he should prefer the fan. The machine was very expensive to keep in repair.——Mr. WILKINSON pointed out the different positions of the Lletty Shenkin and Middle Duffryn Pits, and said that if Mr. Williams had the fan he would get the same result. The Middle Duffryn Pits stood side by side in the valley, whilst Mr. Williams had three pits—two on the mountain side and one in the valley, 1000 yards distant below. Mr. Williams had the great advantage of having his ventilation up the mountain side, and the wind from the valley pit having to go up the mountain side, his ventilation was assisted very much.——Mr. BEDLINGTON said it was well known that the principal mode of ventilation was by means of the furnace, and they were all most anxious to know what really was the best mode of ventilation, the importance of which subject could not be overstated. So far as the discussion had gone, it showed the advantage of the fan over Struvé's machine. He believed there was a gentleman present who thought Struvé's machine to be the best, and he should like to hear his opinions. All of them connected with furnaces were anxious to ascertain which was best, if they were to go into mechanical ventilation.

Mr. THOMAS, of Cwmavon, said he had heard what Mr. Wilkinson had said about Middle Duffryn, and he thought he said that from Struvé's ventilator 40,000 cubic feet of air, with 11 strokes per minute, was the largest quantity he could get. He wished to know what was the water-guage?——Mr. WILKINSON: One inch and a half.

Mr. THOMAS said he had been able to get from 56,000 to 58,000 cubic feet, with only 8 strokes per minute, by Struvé's ventilator. He had been connected with the mechanical mode of ventilation at his works for the last thirteen years. Struvé's ventilator was erected in 1854, and he could say that it had worked very well ever since. He thought Mr. Williams said the cost of the ventilator at Lletty Shenkin was very considerable; he thought he said that several fans could be erected at the same cost as one of Struvé's ventilating machines. With that conclusion he begged to differ. As to the result of Struvé's ventilator at their pit, he would observe that they got from 56,000 to 60,000 cubic feet of air through the mine per minute. The length of stroke was 7 feet, and working on an average from 7 to 8 strokes per minute; and he got in the return air-ways from 50,000 to 56,000 and 57,000 cubic feet per minute. He measured it not less than three weeks ago in the return air-way, and he got 57,000 cubic feet, working 7½ strokes per minute. Then with respect to the wear and tear; Mr. Williams had spoken of the destruction caused to the tanks. Now, all he could say was that they had not found it necessary to make any repairs of any amount to their tanks; certainly they were a little corroded, but that was all. As regarded the fan, he knew but very little about it; but Mr. Cope Pearce, in his paper, said he considered there was some difficulty in all mechanical modes of ventilation with respect to the safety of the men in the mines; and he says—"We cannot shut our eyes to the fact that, no matter how well a machine is made, still, after all, it is liable to stop unexpectedly. If this should take place what would become of the men underground? How long they would live with the ventilation stopped? Could they be withdrawn before the air got too foul to support life?" In answer to these observations, he would state that there had been no inconvenience experienced by them if it became necessary to stop the machine. The men knew very well what to do on such occasions; and no accident of any kind has occurred in consequence since the machine had been at work, now 13 years. Neither, he might add, had there been a single explosion. They were obliged to contend with contorted districts, and worked with a small seam, and to get a quantity of air through these small seams was very expensive. To get it through they must get greater power, and they could not get it by any other means than by the mechanical mode of ventilation. With respect to the rubbing surface, he would observe that they passed from 56,000 to 60,000 cubic feet of air through the mine per minute, when the machine worked eight strokes per minute, and that quantity represented by 3 inches of water, or 5·19=1557 per square foot of the area of the passages, and no fan could pass an important amount under such a drag. He meant, of course, the quantity passed would be very small. Their machine, if he would allow it, would put their large copper works chimney air into the colliery, although it was nearly 1200 feet above the colliery, with an average temperature of 400°. The great feature of Struvé's ventilator was that a large body of air could be passed through it with scarcely any resistance. The valve surface was very large, the piston moved in water packing, and the resistance of the valves was scarcely appreciable; from 1-16th to 1-8th of an inch of water might represent the resistance of the valve-work. It was evident from the circumstance that the valve presented no appreciable pressure to render necessary to place the valve-work near the piston. In the blast-engine, if the valves were not as near as possible to the piston, the condensed air would follow the piston, thus diminishing the supply of external air to a large amount. The principle which Mr. Struvé sought to accomplish was the passage of an unlimited amount of air through machinery under the most unfavourable circumstances of contracted conditions in the mines. Whatever the resistance in the mine, Mr. Struvé's machine must fill itself, but with a fan the conditions of resistance might be so great that though the valves moved with considerable velocity, the passage of air which arose from centrifugal force might be very small indeed. The feature, therefore, of Mr. Struvé's machine was the large valve surface connected with the upcast and air-way of the colliery, presenting no appreciable obstacle to the passage of the air with the vacuum produced by the piston. The piston might be a solid piston, like the one at Messrs. Nixon's, at Deep Duffryn Colliery, or a piston with inappreciable friction moving in water. They were still the same machines; but considering how simple was the suspension of a hollow gasometer form of piston in water, with no rubbing surface, it was, in his opinion, preferable to a solid piston moving through a case of masonry. Mr. Nixon's machine was erected after the expiration of Mr. Struvé's patent; and, of course, anyone now might put up those machines and use any form of piston. He believed that Mr. Struvé had put up a dozen of those machines. The average quantity of air produced by the machines was from 56,000 to 60,000 cubic feet, with a water-gauge of 3 and 4 inches. He had no hesitation in saying that furnace ventilation could never do that. The upcast pit, where the machine was fixed at Cwmavon, was 66 yards deep; and to produce the same result by a furnace fixed in that pit would require 750° temperature in the upcast, which would be quite impracticable to obtain. Take the average quantity of air coming up the upcast to be 56,000 cubic feet per minute, and the average area of the air-ways in the mines to be 28 ft.; the water-gauge by 3·5 in. of water; pressure per square foot of the air-way=18·16 lbs.; pressure on the whole air-way=508·48 lbs., 56,000×508·48 lbs.=86 horse-power required to draw that quantity per minute through the mines.

In reply to questions, Mr. THOMAS said he stopped the men three or four hours at the end of the week, from 6 till 8 or 10 o'clock on Saturday, and the stoppage was principally to examine the valves, for if they did not keep them clean they lost a great quantity of air. During the stoppage an accumulation of gas took place in several places, but it was generally removed in a couple of hours.——The PRESIDENT: Then the men do not work in the pit when the ventilation is stopped.——Mr. BEDLINGTON: Do you work with naked lights or locked lamps?——Mr. THOMAS: Locked lamps.

Mr. BROWN said they could not overrate the importance of the question that had arisen that day, and he thought there had been hardly time to give it due weight and consideration at that meeti

It behoved them all to see if they could do anything themselves in bringing about any improvement, and make the thing better than they had it. As to the observations of Mr. Murphy about the doors, he was glad that he had directed his attention to the subject. He made suggestions, and said he had seen doors very rudely constructed. Now he (Mr. Brown) begged to say that there were many doors made self-acting, but still there were a great many which were not. If Mr. Murphy was going to present a paper on the matter he should be most happy to give him all the information in his power, and he would advise him to endeavour to devise means to do away with the doors altogether. They had doors of all shapes, but their business was to do away with them altogether. He thought the discussion on mechanical ventilation had not been one-half gone through. For himself, he had not had much time to look into the matter, but he would do so, and be prepared to offer some observations at the next meeting. He would, therefore, propose that the discussion be adjourned.——Capt. MURPHY seconded the proposition.

Mr. WILKINSON said Mr. Thomas got much more wind than he did, but that depended on the distance the wind had to travel.

The discussion was then adjourned, a vote of thanks being accorded to Mr. G. Cope Pearce.

The PRESIDENT said the next paper for discussion was "On the Structure of Iron," by Mr. W. Vivian:—

The subject which the writer proposes to bring before you is one which, he believes, has not hitherto received much attention. Fairbairn and others have experimented upon the properties of iron, but he was not aware that they had devoted their attention to the minute conditions of structure on which the mechanical properties, such as malleability, tenacity, and ductility seem to depend. Having for some years made observations on this subject, and believing it to be an important one, while it opens out a wide field for further enquiry, the writer ventures to draw your attention to the following results, which may be tested, and, he believes, verified by any careful observer who is able to use a good microscope. Metals, in their minute structures, may be divided into two leading divisions—the angular or crystalline, and the cellular or porous, and of these two divisions all metals are constituted, and none are absolutely solid; all have void spaces, either in the form of cells, or between the angles of the crystals. If it were possible to compress any one given metal into a solid state its bulk would be diminished and its density increased immensely; and this assertion is not made at a venture, but is founded upon long observation on all the commonly known metals, with many of their alloys. It is remarkable that the best known conductors of heat and electricity, such as silver, copper, and iron, are those metals which show in their structure the cellular system most highly developed; and that their several powers of conduction are in the same ratio and degree as the perfection of their cell system may be. The writer intends, however, to confine his remarks for the present to the structure of malleable iron, and may say, at once, that all good iron, even the best that is manufactured, is as porous as a sponge. It is well known that good iron, when fractured, shows what is called "fibre"—a silky lustre—which is nothing more or less than light reflected from the fracture. If the iron is cut by a tool there may be a bright appearance shown in the cut, but that peculiar soft silky lustre does not then appear; for the action of a tool, wherever it comes into contact with the metal, destroys this appearance; neither is this soft lustre ever seen on the exterior, or on what is commonly called the skin of the metal. This peculiar appearance, then, is derived from myriads of minute elongated cells, whose inner surfaces before they are long exposed to the air are exceedingly brilliant, and will reflect light beautifully. These cells appear to be more or less spherical in their normal state, but are elongated by rolling in the manufacture. The light-reflecting surfaces are the partitions between the cells, which often open out into each other laterally and longitudinally, probably affording a continuous line of communication for the passage of heat and electricity in vacuo. That air has no access to them in their normal state appears to be shown by the fact that, although when first laid open they reflect light brilliantly, but that they soon tarnish on exposure to the atmosphere. If a bar of iron is broken off at right angles to the line of rolling it has then a dull grey colour. The reason of this is that the observer is then looking down into the dark depths of the cells, from which no light can be reflected; but if in breaking the cells are divided longitudinally, and slightly bent over on one side, then the most lustrous effects are seen. The writer wishes it to be distinctly understood that this cellular structure is not an accidental occurrence, nor confined to iron of any particular manufacture, but is apparently the proper constitution of the metal, produced under the operation of fixed laws. He has examined a large number of specimens taken indiscriminately from plates, bars, and wire, as they have come into the market, the produce of a great many different markets. A somewhat similar structure may be often seen in other substances that have solidified from a state of fluidity by fusion, such as slag from the furnaces, glass, pitch, and wax; but in all these the cell is more spherical than in iron—a difference which, it seems to him, may be accounted for by the modification of the form of the cell in iron by the process of rolling. The formation of the cell appears to have taken place under the combined effects of heat—the repellant force and the cohesive force inherent to the metal counterbalancing each other.

Perfect fluidity by fusion seems to be obtained by the introduction of so much heat as to overcome the cohesive force, and drive the molecules apart from each other; but when the heat is reduced by radiation or conduction, the cohering force again comes into play till the equilibrium is gained, and each molecule is balanced at a certain radius from the centre, solidifying in the arch or spherical structure as the heat passes away. It is not easy to demontrate this theory, or, perhaps, make it very intelligible to those who have not previously given any attention to it, but the writer has by him specimens of other substances, which may give an imperfect idea of what is meant. If, then, all good malleable iron is perfectly cellular, as the writer has reason to believe it is, there seems to him no reason to doubt that upon the perfection of the cell system its mechanical properties of tenacity and strength must greatly depend, and, indeed, as much importance need be attached to this as to the degree of chemical purity necessary to ensure a good iron.

It is well known to those practically acquainted with the manufacture that a metal of the same degree of chemical purity may produce bars of a superior or inferior quality, according to the degree of heat under which it is taken from the furnace and worked, and the rapidity or slowness with which it may afterwards cool—that is, if the metal is worked at the right temperature, it may produce good fibrous iron; but if worked too hot the iron will prove short and crystalline, whatever its chemical condition may be. In examining specimens of this kind, the writer finds that iron otherwise good, but worked too hot, is thoroughly crystalline; strictly speaking, there are no angular prisms, but only myriads of sets or planes crossing the cells at right angles to them, and thus cutting them short—rupturing the cell system throughout. The question of how this character of iron is thus produced appears to be answered in this way: the iron has worked before the proper equilibrium had been established between the heat and the cohesive force; or it may be produced by the sudden and violent escape of heat, for he finds by experiments made that good malleable iron may be changed into poor short iron, by heating it to a high degree, and then suddenly cooling it in water. He has specimens cut from the same bar in immediate contiguity, showing the difference of structure to be so great that experienced workmen did not believe they were taken from the same bar.

The process of rolling iron into plates or sheets does not obliterate, but modify, the forms of the cells; they remain afterwards as hollow spaces, widened out laterally; the thin partitions which divided the cells at first are now laminated over each other, and upon the regularity of this lamination the strength and quality of the plate will very much depend. The writer has seen boiler-plates which were believed to be of superior quality, and, though the iron might have been chemically good, it was, nevertheless, unfit for the purpose for which it was intended. He thinks it, therefore, desirable that, in addition to the usual tests, iron intended to bear great strain, and, especially where human life is dependent upon its good quality, should be submitted to a close microscopic examination into its structure, as another safeguard against danger.

In wire drawing more than in ordinary rolling the cells are elongated, and the tenacity of the wire depends very much also upon the manner of drawing it. If the cells are violently parted asunder, instead of being merely elongated, the strength of the wire is proportionately reduced. If, for instance, during the process of drawing the wire is annealed to render it more soft and flexible for further reduction in size, the wire is not so strong afterwards as if it had not been annealed at all. The annealing in this case appears to have expanded the cells unduly, even to the bursting of the partitions between the cells. Not to lengthen these remarks unduly, the writer will only say that lately other persons have made discoveries on the properties of iron that may be adduced in confirmation of what has been advanced. Mr. Graham, of the Mint, in a paper which he lately read before the Royal Society, stated that iron at a low red heat would absorb a large quantity of carbonic oxide gas, and retain it, not in chemical combination, but permeating the metal mechanically, and would afterwards deliver it up if required; and St. Clare Deville, of the Normal School of Paris, has also found that by passing gasses through an iron pipe heated to redness, under pressure, they would escape laterally through the sides of the pipe.

Mr. ADAMS suggested that the discussion should be adjourned, which was agreed to after a few questions had been put to Mr. Vivian by Mr. Maynard, Capt. Murphy, and a few other members, which Mr. Vivian answered.

The following papers were then read:—On "Pumping and Winding," by Mr. G. Cope Pearce; and on "The Coal Brasses of the South Wales Basin," by Mr. Adams. The reading of the following papers was adjourned:—On "The Tillery Coal Seam and Workings, Abertillery," by Mr. T. Dyne Steele, C.E.; and on "Davies's Self-Acting Steam-Stroker," by Mr. D. Davies.

A vote of thanks to the President brought the proceedings to a close. The members subsequently dined together, under the presidency of Mr. George Martin, the vice-chairman's duties being performed by Mr. E. Brigden, secretary. The usual loyal and complimentary toasts having been duly honoured, most of the members left to proceed home by train.

PUDDLING FURNACES.—A new puddling-furnace has been patented by Messrs. BAKER, HARLAN, and BELL, which consists in an improved construction of the chill and the iron bed in the puddling chamber in the location of the chimney and exit-flue relatively to the iron or puddling chamber, and in the structure or form of the exit flue. Also, in constructing the entire furnace above ground, and dispensing with a large portion of the brickwork hitherto required and used, by which means the expense of building is reduced materially, and the time required to build it diminished. Also in providing a raised border or chill of the iron chamber with a channel, space, or groove running through it for receiving water or air, which is supplied at intervals, in order to preserve the chill from injury in consequence of the intense heat to which it is exposed. Also in constructing a chill of wrought-iron. Also in a novel method of arranging the fire-grate relatively to the iron chamber, which arrangement tends to save fuel, reduces the size, and hence lessens the cost of the fire-bridge. Also in an improved method of arranging and constructing the stack in connection with the furnace, which enables the patentee to dispense with a portion of the throat or neck of the exit-flue between the stack and the iron chamber. Also, in constructing the furnaces with passages or spaces wherein the surplus air or steam from grooves or steam and air-channels in the chill is conducted off, and discharged into the open air. And, also, in the means for joining or building two furnaces back to back to form a double furnace, and several other novel devices and improvements. The furnace is constructed generally in the usual manner, of iron and fire-brick.

ACCIDENT POLICIES OF MINING ENGINEERS.

The following letter has been addressed to the Editor of the *Times*:

SIR,—The awful catastrophe which occurred at the Oaks Colliery, near Barnsley, on Dec. 12, is fresh in the memory of all; and the announcement in your columns that it had caused the death of more than 200 persons, a greater number, if I mistake not, than had been killed in any former colliery explosion, sent a thrill of horror throughout the land. On that occasion deeds of noble and heroic daring were performed, which deserved, and received, universal applause. Not the least among these were the acts of the engineers in charge of the colliery, Mr. Parking Jeffcock and Mr. John Brown, both in the prime and vigour of life. Fearless of death, they went down the pit without a moment's hesitation, just as other mining engineers would assuredly have done. Mr. Brown came up alive, but Mr. Jeffcock never returned, and all that is mortal of him still lies festering in corruption at the bottom. Both gentlemen had insured their lives for 1000*l.* each in the office of the Accidental Death Insurance Company, believing that their policies would not have been vitiated by such conduct as I have narrated, However, the company has refused to pay the premium on Mr. Jeffcock's policy, alleging as the ground that he was guilty of placing his life in "voluntary danger," in direct contravention of a special clause in the policy. In reply to questions put to them by Mr. Brown, they say "all the risks incident to your profession are covered by your policy, but you are expressly forbidden to place your life in voluntary danger under any circumstances whatever."

Thus, it would appear that if a mining engineer goes to the scene of disaster after an explosion in a coal pit he incurs a risk, according to the Accidental Death Company, not incident to his profession. They add, "It is the true characteristic of nobleness that it be disinterested. It cannot be disinterested if the direct consequences be to secure pecuniary benefits which under other circumstances would not accure." Well, Sir, it can hardly be supposed that any consideration of his policy could have entered the head of poor Jeffcock before he ventured upon what he conceived to be his duty,—a duty necessarily incidental to the profession of a mining engineer, especially a colliery engineer. While I do not venture to dispute the judgment of the Accidental Death Company on the point in question, I submit to you, Sir, that as it is possible serious misapprehension on this subject may exist among insurers in this company it is desirable the public should know distinctly the circumstance which may render their policy invalid. If, for example, the Duke of Sutherland holds a policy of the company, he would do well to remember that if in future he play the part of an amateur firemen, however efficiently and advantageously to the public, he may "place his life in voluntary danger." Nay, even in the case of the chief of the London Fire Brigade, Captain Shaw, supposing him to be insured, the same proviso will apply. In conclusion, I have only to add that, in writing this letter to you, I am actuated not by any feeling adverse to the directors of the Accidental Death Company, but by a wish to put the public on their guard in this matter. Y.

The following correspondence on this subject has passed between Mr. John Brown, of Barnsley, and the Secretary of the Accidental Death Insurance Company:—

TO THE SECRETARY OF THE ACCIDENTAL DEATH INSURANCE COMPANY.

SIR,—It is reported that your company have, for some reason or other, objected to pay the insurance due under a policy held by Mr. Parkin Jeffcock, who was killed at the Oaks Colliery on Dec. 13 last. I hold a policy in your company, No. 12,884, which requires renewal on April 7, but before I do it I shall be glad if you will favour me with an answer as to whether the above is true or not? I was seven hours underground at the Oaks Colliery on Dec. 12, and spent some time with my friend Mr. Jeffcock in the pit on the evening of that day.

Now, as it is my business to go down pits, and I could not shrink from doing so under such circumstances as required his and my attendance, and as I have for many years paid a premium, which I always understood was to cover the risk that mining engineers ran, upon the implicit faith that no respectable company would repudiate its engagements, I was much amazed at the report. I trust that it is quite untrue, otherwise I shall not renew my policy, and shall advise my friends to adopt the same course. JOHN BROWN.

Harbro' House, Barnsley, March 19, 1867.

TO MR. JOHN BROWN, BARNSLEY.

SIR,—All the risks incident to your profession are covered by your policy, but you are expressly forbidden to place your life in voluntary danger, under any circumstances whatever. We are fully sensible that the noble characters of many of our English engineers will from time to time induce them to make sacrifice even of their own lives to save the lives of others. But it is the true characteristic of nobleness that it be disinterested. It cannot be disinterested if the direct consequences be to secure pecuniary benefits which under other circumstances would not accrue. We do not take such risks into account in calculating the premiums we charge, or they would be very much increased; for that reason we specially exclude such risks from our policies. Mr. Jeffcock had been personally well known to one of our directors for many years, and was held in high estimation. W. H. SCATTERGOOD, Secretary.

Accidental Death Insurance Company, London, March 22, 1867.

SIR,—I have your favour of the 22d inst., in reply to mine of the 19th instant. I cannot at all understand your version of the term "disinterested." It cannot surely be imagined for one moment by your directors that any mining engineer would rush into danger *on purpose* to get killed in order that your company should have to pay 1000*l.* to his representatives. This decision of your directors strikes so deeply and would tend so much to make mining engineers cowardly that I intend to lay the matter before the public at some convenient opportunity.

Harbro' House, Barnsley, March 25, 1867. JOHN BROWN.

SIR,—We can have no possible objection to your bringing the subject of accident policies of mining engineers before the public in any way you may consider prudent; but if you have occasion to mention our practice in the matter you will be careful, I am sure, not to misrepresent us. The premiums we charge only covers the risks ordinarily incident to the profession, and we expressly prohibit them (and all our other policy-holders) from placing their lives in voluntary jeopardy. We could quote a rate that would cover even the risk of descending mines after explosions and before precautions of safety were taken, but it would be a very heavy rate indeed. I think some publicity on the subject might do good, for all reasonable men would see the essential difference between ordinary professional risks and voluntary exposure to great personal hazard.

W. H. SCATTERGOOD, Secretary.

Accidental Death Insurance Company, March 29, 1867.

SIR,—Your letter of the 29th inst. has reached me here to-night. I beg to state in reply thereto that, in making the matter public, I will take care not to misrepresent the facts. JOHN BROWN.

Bedford Hotel, Covent Garden, March 30, 1867.

[Some remarks on this subject appear in another column of this day's Journal.]

SUNLIGHT IN THE MINES.

Amongst those whose acquaintance with colliery operations, and with the interior of collieries, is limited to what they have read in books it is customary to regard an explosion as the most lamentable casualty to which the collier is exposed; yet an examination of the statistics annually supplied by the Government Inspectors of Coal Mines (and the abstracts published in the *Mining Journal* of March 16 may be taken as representing the fair average), will show that the deaths resulting from explosions are but few in comparison with those from other classes of accidents, although the circumstance of explosions usually killing the miners wholesale gives them a sensational character, whilst no thought is taken of the far more frequent accidents by which the men are killed singly. Taking the average of the last two years, it appears that for every death resulting from explosion three deaths occurred through falls of roof, and that the deaths resulting from accidents in shafts were considerably more numerous than those caused by explosions; hence it follows that quite as much attention should be paid to "falls" and "shaft accidents" as to explosions, if it be desired to reduce the number of colliery fatalities to the minimum.

That a large number of the deaths from falls of roof, as well as some of those classified as shaft accidents, occur through insufficient knowledge of the faults and irregularities of the strata is beyond question, and it has ocurred to Mr. LARKIN, whose beautiful magnesium lamp attracted so much attention at the last meeting of the British Association, that if a reliable and portable lamp could be placed in the hands of the chief underground manager of a mine, which should enable him to make himself thoroughly acquainted with the most minute details of the structure of the roof, and of any changes which may from time to time take place, an important end would be gained; he has, therefore, constructed a hand-lamp, not much heavier than an ordinary Davy, capable of producing the magnesium light with certainty and regularity, and containing no clockwork or other mechanical arrangements to get out of order.

The new lamp is very compact, and throws a most brilliant light. A spirit-flame is used to ignite the magnesium, and as the flow of the powder can be instantly stopped and recommenced, there is every facility for securing economy, by using the light only during the precise period when it is required. The magnesium is used in the shape of granulated crude metal, either alone, or diluted by being mixed with sand in varying proportions, according to the volume of light required. It is necessary that the powder should be kept beyond the reach of the atmosphere, to prevent deterioration, but this presents no difficulty to the consumer, as it is supplied in suitable cases. The light is well worthy the attention of surveyors, inspectors, and managers of all kinds of mines, and is not excessively costly for the special purposes indicated.

Mr. Larkin's lamp might also prove of great value to railway engineers, to enable them to carry "daylight" into the tunnels, and so examine, more thoroughly than would otherwise be possible, the condition of the roofs, &c. Mr. How, of Foster-lane, exhibited one of these new magnesium lamps, burning the undiluted metal, at the recent *conversazione* at Guy's Hospital, and excited considerable interest by the extraordinary light thus simply produced, which made the other lights in the brilliantly-illuminated saloon look singularly dim and powerless.

COAL IN AUSTRALIA—THE LAMBTON COLLIERY.

The question of a sufficient supply of coal for the growing requirements of all parts of the world is one of great commercial and national importance. For some years our Australian colonies have produced coal, but, until comparatively recently, it has not been greatly used, nor has its production been much taken into consideration by those who have devoted their thought to the subject of the probable duration of the coal fields of Great Britain. A change, however, in this respect appears to be rapidly coming on, the steps taken by the Scottish Australian Mining Company having established beyond a doubt the excellent quality of Australian coal, and its fitness for steam and gas purposes. The directors of that company recently ordered home a quantity of coal from their Lambton Colliery, near Newcastle, in New South Wales, and submitted it to an impartial trial by the English Government, with results which show very plainly that it can compete successfully in the Australian, Indian, Chinese, and other foreign markets with the best coal shipped from England. The following is the report by the Government on the trial in question:—

[EXTRACT.]

"*War Office, March* 6, 1867.—SIR: I am directed by the Secretary of State for War to acknowledge the receipt of your letter of Feb. 28, and in reply I am to transmit to you copies of the reports made by the Superintendent of the Royal Laboratory at Woolwich, and by the chemist of the War Department, upon the trial of the 'Lambton' coal submitted by the Scottish Australian Mining Company, through the Secretary of State for the Colonies, in the month of November last. "J. ST. GEORGE, Major-General, Director of Ordnance.

"The Secretary to the Scottish Australian Mining Company,
1, King's Arms-yard, Moorgate-street."

[COPY.]

"Report of a trial made in the Royal Laboratory, Woolwich, to test the quality of a sample of 'Lambton' coal (New South Wales), submitted by the Scottish Australian Mining Company (Limited), in comparison with first and second class Newcastle coal (English), the conditions of trial being the same in each case. The boiler used was 20 ft. long, 6 ft. diameter, with 2 internal flues, fired fh the centre. Area of each fire-grate, 11 ft. = 22 ft. total, with Chanter and Annan's reciprocating fire-bars. Boiler set with a 'wheel draft,' steam being up to 45 lbs. when the test commenced, and height of water in glass gauge accurately marked. The water meter (Kennedy's) was previously tested, and the boiler kept continuously at work 8½ hours, the pressure of steam varying from 45 to 50 lbs., the temperature of feed water averaging 90°. At the end of the 8½ hours the pressure of steam and height of water were the same as at the commencement. The results of the trial were as shown in the following statement, viz.:—

		Australian coal.	1st class Newcastle or Hartley's Hastings (English).	2d class Newcas. or Buddles (English).
Coals consumed	In lbs.	3542	3542	3542
	cwts. qrs. lbs.	31·2·14	31·2·14	31·2·14
Water evaporated	Gallons	2600	2700	2430
	lbs.	26,000	27,000	24,300
Ditto per lb. of fuel	lbs.	7·34	7·62	6·86
Fuel consumed per foot of fire-grate per hour.	lbs.	18·94	18·24	19·7
Total weight of ashes or refuse	lbs.	179	164	346
Weight of ashes per cwt. of fuel consumed	lbs.	5·6	5·16	10·94
Time occupied in trial	hrs. min.	8·30	8·50	8·10
Aver. pressure of steam.		47	45	35

The Australian coal burnt very freely, requiring comparatively little stoking, and no black smoke was emitted from the chimney during the trial.

"E. M. BOXER, Superintendent R.L.

"Royal Laboratory, Woolwich, February 11, 1867."

From this trial of Lambton and other coal, made at the Royal Laboratory, it will be seen that the company's Lambton coal is, on the whole, equal to the best English Newcastle coal, the average pressure of steam obtained from it during the trial being even greater than that obtained from the English coal.

"Report of the Chemist to the War Department on the Results of Examination of a Sample of Coal from Lambton Colliery, Australia.

"The sample consists of a bituminous coal, undistinguishable in appearance and general properties from Newcastle coal (English). A heap, 32 cwts., was carefully looked over for pyrites, and the coal was found remarkably free from this impurity, and it was, moreover, very uniform in quality. Two average samples were taken for analytical examination, and proved almost identical in composition. The percentage of ash in the two samples was as follows:—No. 1, 4·42; No. 2, 4·60: mean, 4·51 per cent. of ash. The ash was of a pale reddish colour, and consisted of clay, peroxyde of iron, and a trace of carbonate of lime. The mean percentage of sulphur in the two samples was 0·55. When heated in a close vessel, the coal furnished 61 per cent. of a light porous coke. These results show that the sample of coal submitted is fully equal in quality to Newcastle coal (English) of the best kinds. The following results of examination of average samples of Newcastle coal (English) used in the Royal Arsenal are given for comparison:—

	Bebside Colliery.	Hastings Colliery.
Ash (light red in colour)	7·15 per cent.	5·35 per cent.
Sulphur	0·96 per cent.	2·00 per cent.
Coke	66·5 per cent.	65·0 per cent.

"F. A. ABEL, Chemist of the War Department.

"Chemical Department, Woolwich, Feb. 5, 1867."

The results of the foregoing examination of Lambton and other coal by the chemist of the War Department are repeated below in a tabulated form, for the purpose of comparison, viz.:—

	Lambton Colliery (Australian coal).	Hastings Colliery (English coal).	Bebside Colliery (English coal).
Ash (light red in colour)	4·51 per cent.	5·35 per cent.	7·15 per cent.
Sulphur	0·55 per cent.	2·00 per cent.	0·96 per cent.
Coke	64·00 per cent.	65·00 per cent.	66·50 per cent.

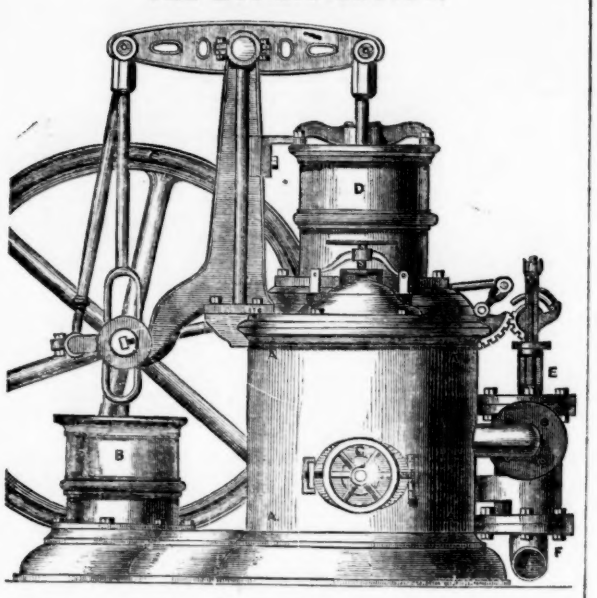
We are informed that the price of this coal, free on board at Newcastle, New South Wales, is only 9s. 3d. per ton at present. It is satisfactory to know that large specimens of the Lambton and other Australian coal are to form an important feature in the New South Wales Court of the coming International Exhibition at Paris. The following are the intercolonial and foreign exports of coal from Newcastle, New South Wales during six months ending Dec. 31:—Melbourne, 63,573 tons; Adelaide, 18,514; Wallaroo, 24,078; Tasmania, 6625; Otago, 11,062; Wellington, 11,719; Nelson, 6081; Lyttelton, 8601; Auckland, 8588; Shanghai, 8340; Hong Kong, 9781; Singapore, 598; Java, 7284; San Francisco, 14,013; Valparaiso, 5310: total, 204,117 tons.—*Money Market Review.*

PREVENTION OF COLLIERY EXPLOSIONS.—Mr. SMITH, of Compton Road, Islington, desires that his plan for cleansing collieries from foul gases should be practically tested, in order that the value of his six years of research may be ascertained. He writes—"My remedy is this—A small stream of water conveyed through a pipe along its top part from shaft to the extreme end, a gutter underneath this upper pipe to receive and convey the water to shaft, connected only by the stream of water to each other (say) fall of water from upper to lower pipe); the only care needed is that the small vacuum caused by the water passing through the air in pipe or gutter be not impeded. I will willingly explain to any person interested in pits the action or power I derive by having one course of water above the other, and especially they being connected by the fall of water."

PNEUMATIC HAMMER.—An improved hammer, the invention of Mr. WALTON, was introduced at the last meeting of the Liverpool Polytechnic Society, which consists of two cylinders, of different diameters, one upon the other, communicating internally. The larger being uppermost, has a tightly-fitting piston, which is moved up and down by suitable machinery. In the smaller is a piston, also fitting accurately, to which the hammer head is attached by means of a rod passing through a collar. This moves up and down, according as it is acted upon by the pressure of the atmosphere, or that produced by the larger piston acting on the air enclosed between the two; and it is by the latter pressure that the blow is produced. The larger piston is usually made about eight times the area of the smaller one, which proportion would, theoretically, cause the smaller piston and hammer to rise 8 inches for every inch the larger one is raised; but in practice a greater proportionate rise of the larger piston is found necessary, more especially when uniform blows at a high speed are required. In order to control the force of the blow, or to stop the hammer altogether, a valve or stop-cock is screwed into the larger cylinder, and is worked by a handle and rod. On opening this cock to the full extent, the smaller piston and hammer cease to move, because the air passes freely in and out of the cylinders through it; but when this cock is completely closed, the hammer acts with its full power, any intermediate strength of blow being obtained by opening it more or less, as required. A slide or valve is provided at the bottom of the small cylinder, for the purpose of giving additional command over the force of the blow; and by partially closing it, so that the smaller piston compresses the air below it, the light "pick up" blow is obtained, which is required for planishing thin metal. The natural position of the hammer when the cock screwed into the large cylinder is open, would be down upon the anvil face. To prevent the inconvenience of having to lift the hammer each time before placing any work upon the anvil, a frictional clip is provided in the smaller cylinder cover, which is moved by a handle, and which clips the piston-rod so as to hold it in any position when the cock is open. The clip consists simply of a sliding block, which is inserted into the cylinder cover, and is pressed against the piston-rod by an eccentric portion of the spindle, upon which the handle is keyed. With very little practice the workman is able to move the handle at the right moment, even at high speeds of the hammer, and so to suspend the hammer above the anvil and out of his way. Two small brass valves are also added, which make the action of the hammer much more certain, and render higher speeds attainable. These valves are not shown in the diagram, their position only is marked. A valve which opens into the cylinder allows a very small quantity of air to enter at each upward stroke, but prevents its return at the downward stroke. A valve which opens outwards from the smaller cylinder allows of the escape of the extra volume of air admitted by the valve in the larger cylinder, after the smaller piston has been driven below the point in the smaller cylinder at which such valve is placed. Both valves can be set to open, more or less, at pleasure; and the effect of them is to adjust the volume of air contained between the two pistons after each stroke, and to provide a small surplus of air at such down stroke, ensuring the decisive descent of the smaller piston and hammers. The complete

hammers are made in sizes varying from 9 in. upper to 2½ in. lower cylinders, to 14 in. upper and 4½ in. lower cylinders; the weight of the hammer-heads being 16 lbs. and 60 lbs., and the length of stroke 10 in. and 18 in. respectively. The power required to drive a machine of the smaller size is just equal to that required to drive a 6-in. turning-lathe; a boy could drive it easily. The machine can give from 200 to 350 blows per minute, according to its size, and will execute as much work as four men.

THE HOT-AIR ENGINE.



Reference was made a few weeks since to the formation of an English company for introducing a hot-air engine, which has been most favourably received in America, and has given great satisfaction in the instances in which it has been already introduced here. It is claimed that it differs from the ordinary caloric engine in several most essential particulars. The motive power, instead of being derived from the expansion of air, heated in a separate generator placed over a furnace, is produced by the expansion of air heated by contact with the fuel itself, and, in addition to this source of power, by the action of the expansive force of the gaseous products of the combustion of the fuel—carbonic acid, carbonic oxide, nitrogen, &c., which, heretofore, have been permitted to escape into the chimney without being in any way utilised in the production of power. This is accomplished by placing the fuel in a furnace, which can be hermetically closed, and forcing the air required for combustion into it by means of an air-pump worked by the engine itself, so that no part of the heated air, or the gases produced by the combustion of the fuel, can escape without passing through the cylinder, and there doing duty in the production of force. The fuel—which may be coke, coal, or anthracite—is thus burned under pressure with great regularity, and with the production of a uniform and moderate temperature, and at a rate exactly proportionate to the duty the engine is called upon to perform, thus avoiding all waste of fuel—a result which has not been attained with any form of engine yet introduced.

The heated air, together with the gases produced by the combustion of the fuel, passes at a moderate temperature from the fire-box directly into the cylinder, so that every unit of heat produced is converted into force. The piston is similar in form to that used in what are called trunk engines, and consists of a hollow plunger, to which the piston-rod is attached at the bottom; but the packing is placed around the upper circumference, where the heat is so moderate as to permit of efficient packing and lubrication without any difficulty.

In the annexed engraving, A represents the furnace, consisting of a strong cylindrical cast-iron vessel, lined with thick segments of fire-clay. The fuel is introduced through the fire-door, G, and the fire lighted in the ordinary manner, the draught for this purpose being obtained by opening a valve which communicates directly with the chimney. When the fuel is well ignited, the fire-door, which is made to fit air-tight, is closed and secured by means of a screw. The fly-wheel, C, is now turned round two or three times by hand, and, by working the air-pump, B, forces a supply of air under the fire-bars of the furnace; it here comes in contact with the fire, and a portion of it, in maintaining combustion, combines with the carbon, producing carbonic acid and other gaseous products; while another portion of the air in excess takes up heat, and is thereby expanded. The mixed heated air and gaseous products of combustion speedily accumulate such an amount of expansive force as to set the engine in motion, by pressing on the lower surface of the piston in the cylinder, D. At the end of the upward stroke the expanded gases escape by the eduction-valve, E, through a waste-pipe, F, which may be connected by a common stove-pipe with any ordinary chimney. Each upward stroke of the piston produces a corresponding downward stroke of the air-pump, B, and thus forces a fresh charge of cold air into the furnace, to maintain the combustion of the fuel, and thus to keep up a continuous supply of heated air and gaseous products. The woodcut represents one of the smaller hot-air engines, of one or two-horse power, in which the furnace and air-pump stand upon a solid cast-iron sole-plate, and the supports of the working beam and fly-wheel are attached to the iron casing of the furnace and to the outside of the cylinder—an arrangement which results in exceeding compactness and simplicity of construction; while the number of the constituent parts of the machine is greatly reduced; and last, but not least, the cost price of the engine is materially diminished. It will be seen that the machine we have now described is single-acting, and for engines of from one to three-horse power this form of construction answers perfectly well. In more powerful engines, however, it is preferable to construct them with two cylinders, so that the double action shall produce a more continuous and uniform development of power.

For engines of small power, the hot-air engine possesses many advantages over every other kind of motor—it does not cost more than 1d. per hour to work, no danger whatever attends its use, no water is required, and the management may be learned in five minutes. The English company, formed for introducing the engine here, has been incorporated, with a capital of 15,000*l.*, in shares of 10*l.* each, and from the large field open for the company's operations, it is anticipated that a highly remunerative business may be carried on.

DISTILLATION OF GOLD AND SILVER BY SUPERHEATED STEAM.—The amalgam to be distilled must be immersed in a current of superheated steam of 650° to 750° Fahr. The steam acts at once as the heating and as the mechanical agent, and hastens the distillation, just as a hot current of air increases the evaporation of water. The aqueous vapours charged with mercurial vapour, are condensed together in the common refrigerator; the metal settles at the bottom of the receiver, while the condensed water occupies the upper part. It is curious to observe the liquid thread which flows from the refrigerator; two currents or threads are distinguishable—an upper one, which is water, and the lower one mercurial—there is thus a continual current of both. No concussions occur; the operation goes on as quietly and as easily as the distillation of water. The apparatus employed consists of a cast-iron cylindrical retort, receiving the vessel which contains the mercury; and of an iron worm, through which the vapour or water circulates, heated to the proper degree, and entering the retort traverses it completely. The economical advantages of the new process is stated that simple ebullition and distillation of water are substituted for the difficult and dangerous distillation of mercury, while there is no trouble in managing the fire, no danger of breakage of the retort, no difficulty in removing the metal, and no wear of the retort; in the new process the temperature is constant and fixed, and much lower than the red heat usually employed. One workman alone can manage an apparatus charged with 2000 lbs. of amalgam, as this new process is adapted even to larger dimensions. No useless expenditure of fuel will occur, since the heat employed will not be greater than required for the distillation of the metal. The distillation of 100 kilos. of silver amalgam by the ordinary process occasions a loss of nearly 2 kilos. of mercury, which by the new process is entirely avoided. The use of superheated steam seems to have effected the long-sought solution of the problem of perfectly preserving, not only the workmen from the baneful attacks of mercury, but also effects a great saving of the previous unavoidable loss of this agent.

SALES OF COPPER ORES

COPPER ORES SOLD AT THE CORNISH TICKETINGS FOR THE QUARTER ENDING MARCH, 1867.

BRITISH MINES.

Mines.	Tons.	Amount.
Devon Great Consols	4529	£22,792 9 0
South Caradon	1503	13,469 19 6
Clifford Amalgamated	3291	13,449 4 6
West Seton	1428	8,406 11 6
Marke Valley	1310	5,136 17 6
Prosper United	1230	4,004 15 0
East Caradon	900	3,833 9 0
Wheal Rose	655	3,428 13 0
Wheal Seton	767	3,254 10 0
North Treskerby	640	3,118 17 6
East Carn Brea	668	2,981 14 6
Hingston Down	859	2,967 2 6
Wheal Friendship	500	2,858 12 0
Wheal Basset	437	2,457 10 0
South Frances	420	2,416 15 6
Phœnix Mines	501	2,380 13 0
Devon and Cornwall	560	2,290 19 6
West Basset	366	1,771 14 0
East Rosewarne	273	1,580 3 6
Wheal Emma	285	1,499 1 0
West Caradon	273	1,387 13 0
South Crofty	304	1,357 9 6
Bedford United	277	1,140 0 6
West Tolgus	300	1,130 11 6
Botallack	96	1,112 6 0
Craddock Moor	223	1,081 16 0
Carn Brea	244	1,070 15 6
East Pool	301	1,036 13 0
West Damsel	271	1,035 5 0
Wheal Margery	283	1,024 16 6
Carn Camborne	314	985 5 0
Brookwood	240	981 9 0
Par Consols	180	855 7 0
Camborne Vean	250	847 16 6
Bampfylde	63	841 1 0
Great South Tolgus	152	834 14 0
Great North Downs	155	829 6 0
Rosewarne United	132	818 17 6
Tolcarne	240	815 13 6
East Russell	177	815 12 0
Hallenbeagle	213	744 14 0
Okel Tor	245	685 7 6
Copper Hill	229	676 4 0
Feock Regulus	114	655 10 0
Gunnislake	82	618 6 0
Prince of Wales	75	599 4 0
Fowey Consols	112	556 0 0
North Roskear	120	525 5 0
Wheal Polmear	101	504 9 8
North Grambler	73	495 2 0
East Basset	50	439 12 0
Crenver and Abraham	137	424 0 0
Cargoll	35	410 7 6
Gawton Copper	144	406 18 0
Wheal Crelake	100	368 15 0
Fursdon	60	346 15 0
Wheal Buller	90	340 16 6
Wheal Maria and Fortescue	124	320 10 0
East Grenville	95	304 5 0
Levant	49	267 14 0
Wheal Crebor	55	257 14 0
South Condurrow	30	249 15 0
South Dolcoath	51	248 9 6
Nangiles	51	224 0 6
Emily Henrietta	36	219 12 0
Dolcoath	54	211 9 0
Caradon Consols	38	200 9 0
Rosewarne Consols	40	197 15 0
North Downs	44	185 18 0
South Basset	44	184 7 0
New Cornish	57	181 9 6
Tincroft	44	167 4 0
Wheal Polharmon	42	155 8 0
Wheal Curtis	55	148 7 9
North Crofty	30	147 15 0
Pendeen Consols	21	144 4 0
Boscaswell	18	138 3 0
St. Day United	40	135 13 6
New Treleigh	40	134 0 0
Great Wheal Busy	66	109 17 6
James's Ore	27	107 6 6
Wheal Mary Florence	20	101 10 0
Sortridge Consols	27	96 10 6
Grambler and St. Aubyn	22	95 10 0
Tresavean	24	92 13 0
Great Work	19	86 9 0
South Tolgus	29	83 7 6
Mellanear	37	80 15 0
Wheal Grenville	19	80 15 0
Old Wheal Basset	38	39 0 6
Holmbush	13	33 16 0
Huthnance's Ore	10	27 15 0
Rowe's Ore	11	26 14 6
Cook's Kitchen	11	18 3 0
Michell's Ore	1	4 15 0
Pembroke	4	4 6 0
Total	29,077	£138,295 11 6

COMPANIES BY WHOM THE ORES WERE PURCHASED.

Company.	Tons.	Amount.
Vivian and Sons	4090	£23,212 0 8
Freeman and Co.	2196	10,851 18 10
Grenfell and Sons	2819	15,347 2 8
Sims, Willyams, and Co.	3206	13,771 15 9
Williams, Foster, and Co.	4925	27,267 16 3
Mason and Elkington	2371	10,141 12 10
Bankart and Sons	1815	8,340 8 4
Copper Miners' Company	3345	12,881 9 5
Charles Lambert	790	2,937 9 0
Newton, Keates, and Co.	185	862 10 6
Sweetland, Tuttle, and Co.	2035	8,852 19 6
Penclawdd Copper Company	637	2,285 4 0
Hadland and Co.	123	335 7 9
Goole Alum Company	540	1,207 16 0
Total	29,077	£138,295 11 6

SALES OF COPPER ORES.

COPPER ORES SOLD AT THE SWANSEA TICKETINGS FOR THE QUARTER ENDING MARCH, 1867.

BRITISH MINES.

Mines.	Tons.	Amount.
Berehaven	1268	£ 9,433 3 6
Ballycummisk	89	534 0 0
Tigrony Precipitate	8	104 0 0
Total	1365	£10,071 3 6
COLONIAL.		
Cape	181	£ 3,418 1 0
Newfoundland	336	3,083 6 0
Concordia	101	1,171 2 6
Port Lincoln	41	730 10 0
Currawang	29	253 17 0
African	3	76 11 6
Total	691	£ 8,733 8 0
FOREIGN.		
Cuba	639	£ 9,586 3 0
Cuba Dust	524	6,984 3 0
California	552	5,848 1 0
Spanish Precipitate	19	1,024 11 6
Lisbon Ore	51	493 17 6
Pomona	9	263 5 0
Victoria Emanuel	22	157 1 0
Casali	13	137 16 0
Total	1829	£24,494 18 0
RECAPITULATION.		
Foreign	1829	£24,494 18 0
British	1365	10,071 3 6
Colonial	691	8,733 8 0
Slag, sludge, and sundries	29	517 16 0
Total	3914	£43,817 5 6

COMPANIES BY WHOM THE ORES WERE PURCHASED.

Company.	Tons.	Amount.
Copper Miners' Company	164	£ 1,333 3 8
Freeman and Co.	310	3,528 13 9
Grenfell and Sons	638	7,267 17 7
Sims, Willyams, and Co.	419	8,101 11 0
Vivian and Sons	510	6,362 16 4
Williams, Foster, and Co.	956	8,922 15 3
Mason and Elkington	112	791 7 10
Bankart and Sons	521	4,550 10 8
Sweetland, Tuttle, and Co.	155	1,182 13 10
Landore Copper Company	126	1,776 4 6
Total	3914	£43,817 5 6

PEAT FUEL MANUFACTURE.—For some time past a very simple process for manufacturing peat fuel has been in operation on the estate of Mr. R. M. ALLOWAY, J.P., of Ballybrittas, Queen's County, with great success. On the bog a number of labourers are employed in cutting the peat, mixing that near the surface with the superior quality lower down, and "washing" it in such a manner as to remove from it its natural sponginess, and destroy its fibre. It is then kneaded by the aid of water until reduced to the consistency of mortar. Close to the bog are placed ranges of drying-tables, rudely constructed of common sawed timber, having on the sides several rows of laths nailed short distances apart. Between these ranges are placed three long vessels, about 1 foot deep, with a breadth at the bottom of 1½ foot. The peat, having undergone the process referred to, is removed to the centre vessel, where it is again pounded by means of implements made for the purpose, and afterwards placed in the receptacle at either side. It is then removed to a tray placed on the drying-tables, at each side of which stands a child, whose duty it is to take up a handful of the peat mortar, give it a press, and leave the pieces so formed in rows along the laths, where it remains to be dried by the action of the sun. When the balls are sufficiently dry a sack is held at the side of the table, whilst a person opposite pushes them into it in the most expeditious manner. During the exposure of the peat balls to the sun it becomes greatly reduced and quite hard, so much so that it can be conveyed any distance in bags without sustaining the slightest injury. It is cleaner and more comfortable than pit coal, about the density of Kendal coal, making a charming fire, lasting a long time, with increased heating power over common turf, and slowly consuming away in bright embers. It does not soil furniture, &c., like pit coal, nor are its ashes so liable to fly about as those of common turf or wood, while its price will not exceed 10s. per ton!

SEPARATION OF GOLD FROM ITS ORES.—An improved arrangement of concentrator and separator has recently been designed by Mr. R. CHOPIN, of Sonora, United States. A separator, in the form of a shallow pan elevated an inch above the concentrator, first receives the water, sediment, quicksilver, and gold escaping from the mill above. The bottom of the separator being deeper than the sides or mouth where the water flows over, the quicksilver and gold naturally settles down, while the light sand and sulphurets flow over with the water into the concentrator, which looks somewhat in shape like the shallow top of a soup tureen. Small holes are perforated in the bottom of this concentrator, through which the sulphurets pass into small pans beneath, while everything else flows over the top into conductors, which convey it away. The whole machine is suspended on four stout wires, each fastened at the bottom in a strong framework. Diminutive cog-wheels attached to a cylinder, which is kept in motion by the action of the mill above, sets the machine in motion, and gives both the separator and concentrator the same motion as that of a child's cradle when rocked gently.

BESSEMER METAL.—As an improvement in the manufacture of Bessemer metal, Mr. CAMERON, of Barrow-in-Furness, proposes to employ as fluxes lime, limestone, or other carbonates of lime, carbonate of baryta, and carbonate of soda and potash, iron ore, fluor-spar, and common salt.

"GEOLOGICAL MAGAZINE."—The April number of this magazine contains a more varied and interesting collection of articles, memoirs, &c., than almost any one that has preceded it. The original articles embrace papers "On the Occurrence of Squalodon in the Tertiary of Victoria," by Prof. McCoy; "On an Aroideons Fruit from the Stonesfield Slate," by Mr. W. Carruthers; "On Chelrolepis from the Old Red Sandstone," by Mr. James Powrie; "On Didymaspis Grindrodi, a new genus of fishes, by Mr. E. Ray Lancaster; "On the Geology of South Bedfordshire," by Mr. J. Saunders; and "On the Anglo-Belgian Basin," by the Rev. J. Gunn. There are Notices of "Igelstrom's Memoir on Bituminous Gneiss and Mica Schist, and of that by Mr. E. T. Higgins, "On the Otolites of Fishes," and Reviews of Ansted's "Physical Geography and Geology of the County of Leicester;" Wynne's "Geology of the Island of Bombay;" Maclaren's "Geology of Fife and the Lothian's;" and Close's "General Glaciation of Ireland." The reports and proceedings, Correspondents, Miscellaneous Information, and Obituary occupy the remaining portion of the book.

"QUARTERLY JOURNAL OF SCIENCE."—In commencing an article upon Louis Figuier, contained in the April number of the Quarterly Journal of Science, it is remarked that there are two distinct classes of scientific writers, whose labours tried to raise the intelligence of our age; those, who by the publication of original researches, constitute the pioneers of scientific progress, and those, who appreciating the value of such original researches, and feeling the necessity for diffusing knowledge amongst the masses, in a form in which it will be west understood by them, bring their literary powers to bear in a noble cause, and render comprehensible to the multitude laws and facts which would otherwise by appreciated only by the limited circle of what we are accustomed to call *savans*. The present number affords ample evidence that the editors fully appreciate the importance of the latter class of writing—the eight original articles conveying an enormous amount of information, which might otherwise be passed by as over technical, in the most attractive and interesting style. The Chronicles of Science and proceedings of the learned societies are given with the usual care and conciseness.

"POPULAR SCIENCE REVIEW."—The number of this Review just issued (Hardwicke, Piccadilly) contains six original articles, of which the most interesting to the readers of the *Mining Journal* will be that entitled "An attempt to Approximate the date of the Flint Flakes of Devon and Cornwall," by Mr. Spence Bate, F.R.S. The Reviews and Scientific Summary are of the usual interesting and instructive character. The number contains ample illustrations in elucidation of the papers.

CORNISH PUMPING ENGINES.—The number of pumping-engines reported for Feb. is 24. They have consumed 1888 tons of coal, and lifted 14·9 million tons of water 10 fms. high. The average duty of the whole is, therefore, 53,300,000 lbs., lifted 1 ft. high, by the consumption of 112 lbs. of coal. The following engines have exceeded the average duty:—

Chiverton—Cookney's 60 in.	Millions 59·0
Cargoll Mines—Michell's 72 in.	63·5
Chiverton Moor—70 in.	54·3
Great Work—Leed's 60 in.	58·6
North Roskear—Doctor's 70 in.	64·5
West Chiverton—Hawke's 80 in.	68·5
West Wheal Seton—Harvey's 85 in.	61·1
Wheal Seton—Tilly's 70 in.	73·2

THE PRICE OF TIN.—"A Large Mine Adventurer" writes:—"If the smelters cared only for the 'interest of mining' their conduct would indeed be 'strange and unaccountable,' but I believe that there is in existence something known as self-interest, and perhaps if the adventurers in and the managers of tin mines were to look a little more carefully after this latter quality they would have less need to care for the 'strange and unaccountable' conduct of the smelters. The suggestion that tin should be reserved until it would make 60*l.* a ton would be in many cases simply impossible. Monthly costs and merchants' bills have to be met, and probably but few adventurers could advance the necessary capital. But at the present low price of money few bankers would object to hold tin as a lien at the nominal value of say 40*l.* per ton. It is not a bulky article, it is easily stored, it is not destructible, and does not waste by keeping. If it be objected that many of our bankers are smelters, and would object to make such advances, all I have to answer is that there are quite as many bankers who are not smelters, and who would gladly advance 40*l.* per ton, and consider the security as 'good as gold.'"

Works published at the MINING JOURNAL *office, Fleet-street, London.*

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